

# Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase I

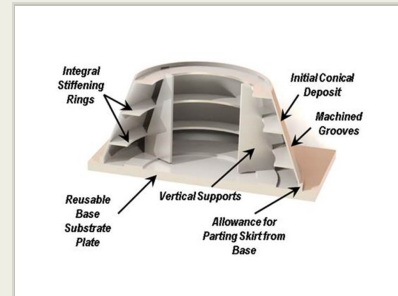
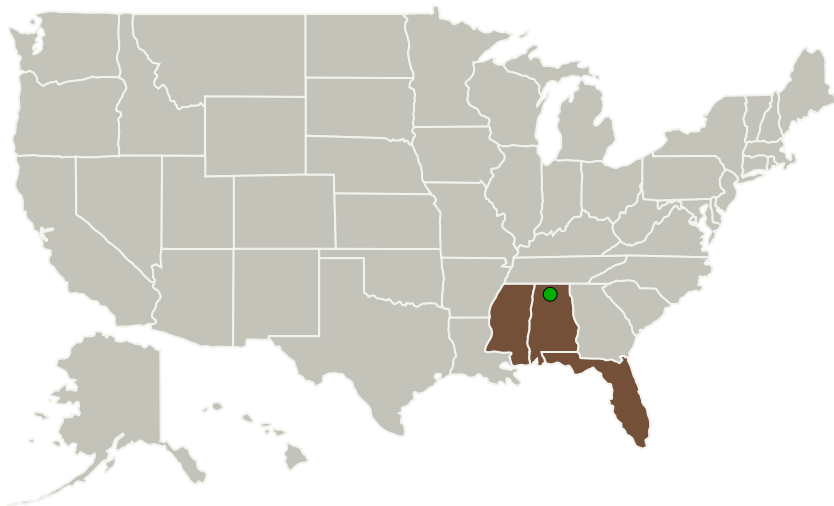
Completed Technology Project (2015 - 2016)



## Project Introduction

Use of additive manufacturing (AM) techniques are of interest as they can be used to create complex shaped rocket components in addition to the potential for multi-material, or functionally graded materials (FGM). The main technical challenge lies in the ability to deposit various materials at relatively large diameters with the desired properties while maintaining the overall structural integrity of the assembly. Use of interface materials can also assist in joining these very dissimilar metals ranging from Cu-based to Ni-based alloys. In response to this need, Keystone, in collaboration with MSU, is proposing a Phase 1 STTR project to demonstrate the feasibility of applying the Robotic Pulsed-Arc AM process to fabricate FGM Cu-to-Ni components in support of advanced engines for the Space Launch System (SLS) vehicle. During the Phase II the Keystone team envisions maturing the processes to AM a 21-inch diameter cooled nozzle for delivery to the NASA for machining and preparation for hot fire testing by the NASA.

## Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Keystone Synergistic Enterprises, Inc.	Lead Organization	Industry	Port Saint Lucie, Florida
● Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Florida
Mississippi	

## Project Transitions

▶ **June 2015:** Project Start

✓ **June 2016:** Closed out

**Closeout Summary:** Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase I Project Image

### Closeout Documentation:

- Final Summary Chart Image(<https://techport.nasa.gov/file/139209>)

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Keystone Synergistic Enterprises, Inc.

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

Carlos Torrez

### Principal Investigator:

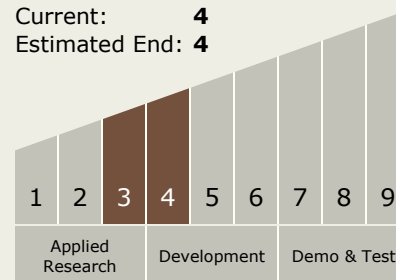
Bryant Walker

## Technology Maturity (TRL)

Start: **3**

Current: **4**

Estimated End: **4**

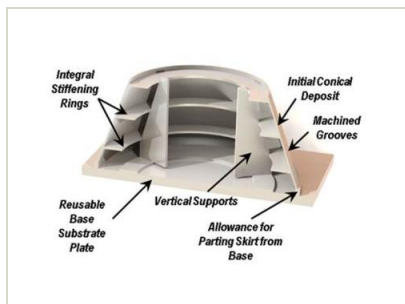


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## Images



### Briefing Chart Image

Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase I  
(<https://techport.nasa.gov/image/135022>)



### Final Summary Chart Image

Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase I Project Image  
(<https://techport.nasa.gov/image/128776>)

## Technology Areas

### Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - └ TX12.4 Manufacturing
    - └ TX12.4.1 Manufacturing Processes

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System